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До зустрічі на UKRAINIAN LIVESTOCK SUMMIT наступного року!

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OPTIMIZATION OF THE FATTY ACID COMPOSITION OF FEED PRODUCTS. PROBLEMS AND PERSPECTIVES

Abstract

Modern trends and changes in the production of food and feed products, the state of natural resource provision for mankind, physiological features of modern high-performance breeds of animals and poultry crosses, features of their maintenance, the structure of the raw material base of the compound feed industry, and the need to change approaches to providing compound feed products with fat have been analyzed. It is shown that the limitation of the introduction of fish and meat and bone meal in compound feed recipes requires the replacement of these components not only from the point of view of protein quality, but also the need to adjust fat both in quantity to ensure the required level of energy value and in quality to ensure healthy life activity of the body. It has been shown that the organism of animals and birds is a symbiosis of two organisms, a macroorganism and a microbiota, with a significant contribution to the coexistence of microbiota, therefore the justification of the choice of components of compound feed products, in particular to provide fat and energy, should be carried out taking into account the further impact on the microbe. The relevance of optimizing the fatty acid composition (FAC) of compound feed products according to the physiological and metabolic needs of modern breeds and crosses of agricultural animals and poultry is shown. Modern ideas about the ways of fat metabolism, the physiological role of individual fatty acids, biological value were analyzed, and the theoretical principles of optimizing the fatty acid composition were developed. It has been established that saturated fatty acids are more resistant to oxidation, able to increase immunity, reduce inflammation, but have a low degree of assimilation, and require mandatory adjustment of bioavailability to avoid disruption of lipid metabolism. Monounsaturated fatty acids have better resistance to oxidative processes, higher availability. Polyunsaturated fatty acids (PUFAs) have low and very low resistance to oxidative processes, which makes it necessary to solve the issue of their stabilization both in vivo and in vitro, since the accumulation of toxic products of lipid peroxidation initiates the appearance of various pathologies and diseases. The nutritional value of pressed and unrefined sunflower oil, soybean oil, high-oleic sunflower



oil, palm oil, coconut oil, and linseed oil were determined; of veterinary fish oil and the ratio of ω -6 and ω -3 PUFAs was calculated in them, the advantages and disadvantages of their use in compound feed were substantiated. It is shown that the introduction of sunflower oil of the linoleic type to provide feed with energy leads to a significant increase in the content of linoleic acid, which is related to the structure of the raw material base and the significant content of ω -6 PUFA in other feed products. Compound feed recipes for different species and groups of poultry were calculated, and it was established that when using fish and meat and bone meal, the content of linoleic acid in compound feed was exceeded by 3 times (up to 3.08% against the norm of 1.1%). Additional introduction of oil of sunflower linoleic type leads to an increase in the indicator for various recipes and species and groups from 3.0 to 5 times, which leads to a violation of lipid and mineral metabolism, the appearance of pathological conditions, a decrease in the productivity of animals and poultry, obtaining low-quality livestock and poultry products. The nutritional value of compound feed products will allow to correct the pathways of lipid metabolism and biosynthesis, to carry out the predicted physiological and functional effect on the body of farm animals and poultry in order to obtain livestock and poultry products of maximum quantity and high quality. Further research is needed to justify the choice of fats and fat-containing feed additives, to improve the calculation recipes of compound feed products, taking into account the optimization of both fat and fatty acid profile.

Key words: fat, fatty acid composition (FAC), compound feed, palm oil, sunflower oil, high oleic oil, fish oil, polyunsaturated fatty acids (PUFA).

Introduction

Fat is an important component of feed, which forms its economic and zootechnical efficiency, determines the quantity and quality of livestock and poultry products – biologically complete food products for humans: meat, milk, eggs [1, 2, 3].

Fat consumption provides from 20 to 50% of energy needs, and is also a source of irreplaceable essential factors necessary for the formation of biomembranes and the biosynthesis of tissue bioregulators [1, 4, 5].

The productivity of farm animals and poultry is determined by more than 50% of energy, up to 30% by protein and up to 20% by other nutrients and biologically active substances.

Deficiency of energy in the diets of modern animal breeds and poultry crosses is a frequent cause of reduced productivity. And as you know, all the internal work of the body, related to the processes of digestion, breathing, hematopoiesis, intercellular exchange, etc., takes place due to exchange energy [1].

It is impossible to provide a solution to the above-mentioned problem without taking into account all modern trends and changes in the production of food and

fodder products, the state of natural resource provision for mankind and the projected directions for solving all threats and challenges (Fig. 1).

In particular: the need to increase the number of livestock and poultry products led to the breeding of modern breeds of animals and poultry crosses, which have significantly higher energy needs for the realization of genetically embedded productivity, low immune status, a discrepancy between the growth rate and the development of physiological functions of the body, demanding on the availability and quality of raw materials, require correction of digestive and metabolic processes [6, 7]. The muscles of broiler chickens grow so quickly that the skeleton and internal organs do not have time to fully form. Broilers have widespread deformation of limbs, lameness, ascites, insufficiently developed cardiovascular system, as a result of heart failure, sudden death syndrome, impaired immunity, they are not capable of any physical exertion [6].

Grain components have the greatest energy value, but even they do not allow solving the issue of meeting the energy needs of modern high-performance animal breeds and poultry crosses (Fig. 2).

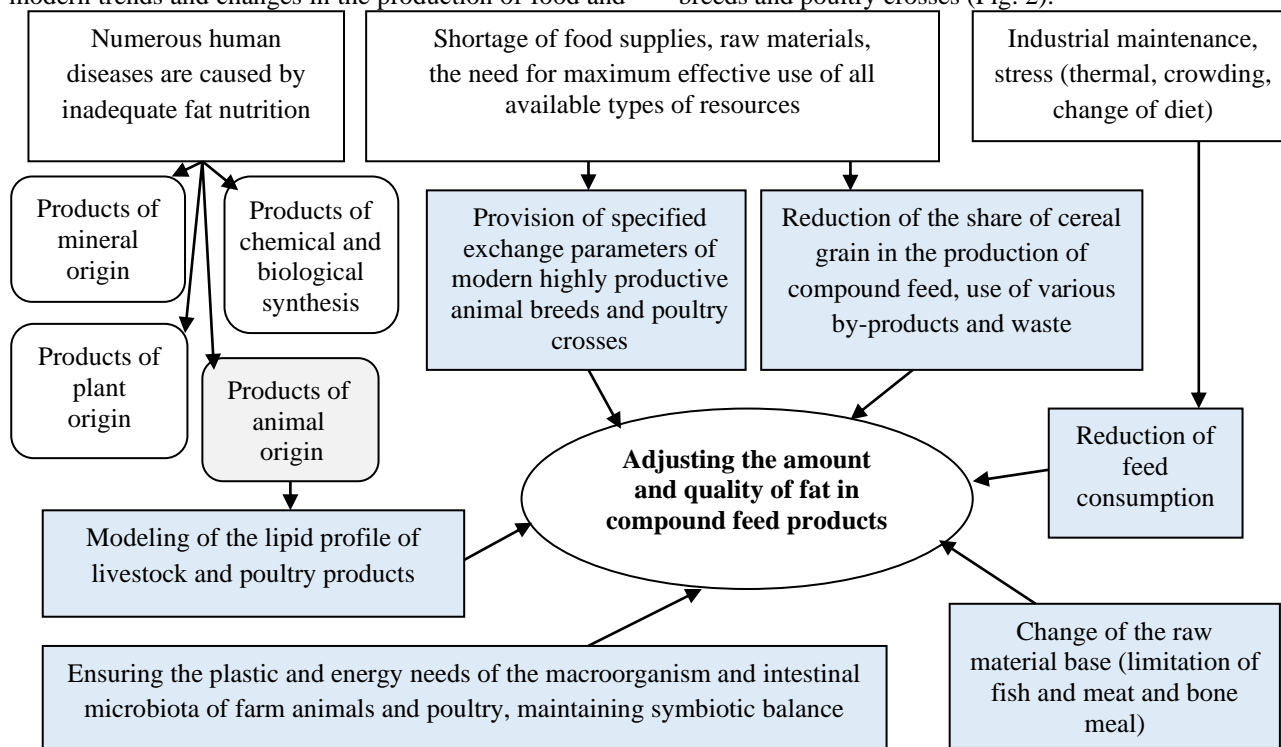


Fig. 1. Prerequisites and factors leading to changes in approaches to providing feed products with fat

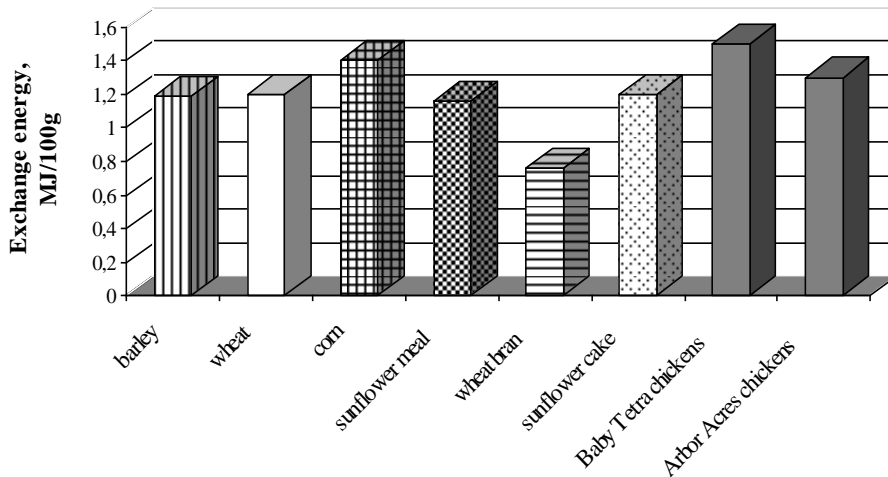


Fig. 2. - Energy value of fodder and requirements of modern poultry crosses

On the other hand, the aggravation of the food and raw material shortage necessitates a more efficient use of cereals for food purposes and a reduction in their content in feed products in order to increase the use of various by-products and waste in the latter, the nutritional value of which is almost half that of grain, which is even more aggravates the problem of energy supply.

Inadequate fat nutrition is one of the most important reasons for the development of the most common non-communicable diseases of people, such as atherosclerosis, coronary heart disease, type 2 diabetes, obesity, metabolic syndrome, etc. [8]. Since 2016, information on the nutritional value of the product has become mandatory in the European Union, and fatty acids must be a separate line.

As a result, the requirements for food products have increased, modeling the quality of livestock and poultry products (fat reduction, optimization, FAC, biological value, etc.) has become an urgent direction.

Industrial keeping of animals and poultry is accompanied by stress, as a result of which feed consumption decreases, which leads to the need to increase the concentration of energy in a unit of feed.

To date, the raw material base of the compound feed industry has changed significantly, in particular: the limited number of such resources as fish and meat and bone meal, the use of which is often accompanied by problems of microbiological insemination, pathogenicity, which does not meet the requirements for the production of safe livestock and poultry products. This led to the fact that in practice these components are practically not used.

Fish and meat-and-bone meal were widely used to balance the nutrition of compound feed products of almost all species and age groups of farm animals and poultry not only in terms of protein, fish meal contains up to 9% of biologically valuable fat with bifidogenic properties. Meat and bone meal contains up to 16% animal fat [1, 2].

Substitution of these components in recipes needs to be justified not only from the point of view of protein content, but also to take into account the need to adjust fat both in quantity to ensure the required level of energy value and in quality to ensure the healthy functioning of the body.

To date, it has been established that the organism of animals and birds is a symbiosis of two organisms, a macroorganism and a microbiota, with a significant contribution to the coexistence of microbiota [9, 10], therefore, the justification of the choice of components of compound feed products, in particular to provide fat and energy, should be carried out taking into account the further impact on the microbiome.

Existing ideas about the essentiality of PUFAs do not take into account the ability of the body of animals and birds to carry out endogenous biosynthesis of essential fatty acids at the expense of endogenous microbiota.

Failure to take into account all of the above factors leads to a violation of lipid metabolism, the appearance of various pathologies and diseases.

Until now, there is no norm of fat consumption for different types of farm animals, poultry, research results available in the literature are scattered, sometimes contradictory, FAC is not taken into account at all, which complicates the issue of effective provision of compound feed products.

When choosing a source of fat, its ability to activate the peroxidation of lipids in the body with the formation of toxic products is not taken into account, especially in the case of the failure of the body's endogenous antioxidant systems and the deficiency of antioxidants in compound feed.

Taking into account the above, an urgent issue is increasing the zootechnical efficiency of compound feed products by optimizing its FAC.

The purpose of the work: substantiation and analysis of the compliance of the quantity and quality of fat in compound feed products with the physiological and metabolic needs of modern breeds and crosses of agricultural animals and poultry.

Research materials and methods.

The following fats and oils were used in the work: sunflower oil, unrefined, pressed (producer: the company "Smak Sonia" V.V. Marchenko), soybean oil, unrefined, pressed (TM "Zemledar", high-oleic sunflower oil "Olyvka", TUU 10.4 -37420386-007:2023 (producer LLC Biochimtech); palm oil (producer Dukees RBD (Malaysia); coconut oil brand Bees (producer PGFOEdibleOilsSDNBHD, Malaysia), linseed oil (TM Zemledar), fish Goat fat is veterinary (manufacturer "O.L.KAR". All research, calculation of compound feed recipes was carried out at the Department of Grain and Compound Feed Technology of the Odesa National Technological University. FAC of fats and oils was determined by the chromatographic method using a Shimadzu QP-5050 chromatomass spectrometer.

Results and discussion.

At the first stage of research, the theoretical principles of optimizing the fat supply of compound feed



for farm animals and poultry were developed.

Properties, physiological and biological effects of feed fat are determined by its FAC. In recent years, the amount of information about the ways of fat metabolism, the physiological role of certain fatty acids, and the biological value has increased (Table 1) [4, 5].

As can be seen from Table 1, saturated fatty acids are more resistant to oxidation, can increase immune-ty, reduce inflammation, but have a low degree of assimilability, and require mandatory adjustment of bioavailability to avoid disruption of lipid metabolism. In addition, saturated fatty acids increase the formation of blood clots and lead to an increase in cholesterol in the blood.

Monounsaturated fatty acids have better resistance to oxidative processes, higher availability.

PUFAs have low and very low resistance to oxidative processes, which makes it necessary to solve the issue of their stabilization both in vivo and in vitro, since the accumulation of toxic products of lipid peroxidation initiates the appearance of various pathologies and diseases.

As can be seen from Table 1, in terms of physiological action, different groups of fatty acids have diametrically opposite effects, which is clearly necessary for the implementation of physiological mechanisms in the body laid down by nature.

This principle is based on the regulatory action of ω -6 and ω -3 PUFAs and the formation of eicosanoids and docosanoids, which differ in their action (Fig. 3) [11].

As can be seen from Figure 2, arachidonic acid synthesizes endohormones that narrow blood vessels, increase platelet aggregation, block blood vessels, increase blood pressure, and initiate inflammatory processes. Endohormones from eicosapentaenoic acid, on the contrary, lower blood pressure and have an anti-inflammatory effect.

The consequences of disturbing the balance of these PUFAs towards an excess amount of a separate group are obvious and predictable.

Table 1 - Biological characteristics of fatty acids

Indexes	Types of fatty acids			
	Saturated fatty acids	Monounsaturated fatty acids	PUFA	
			ω -6	ω -3
Physical condition	solid	liquid	liquid	liquid
Resistance to oxidation	high	satisfactory	low	very low
Digestibility	low	satisfactory	satisfactory	satisfactory
Effect on immunity	increase	increase	reduce	increase
Effect on inflammation	reduce	reduce	increase	reduce
Effect on carcinogenesis	slow down	slow down	strengthen	slow down
Effect on blood cholesterol	increase	reduce	reduce	reduce
Effect on thrombus formation	increase	do not affect	increase	reduce

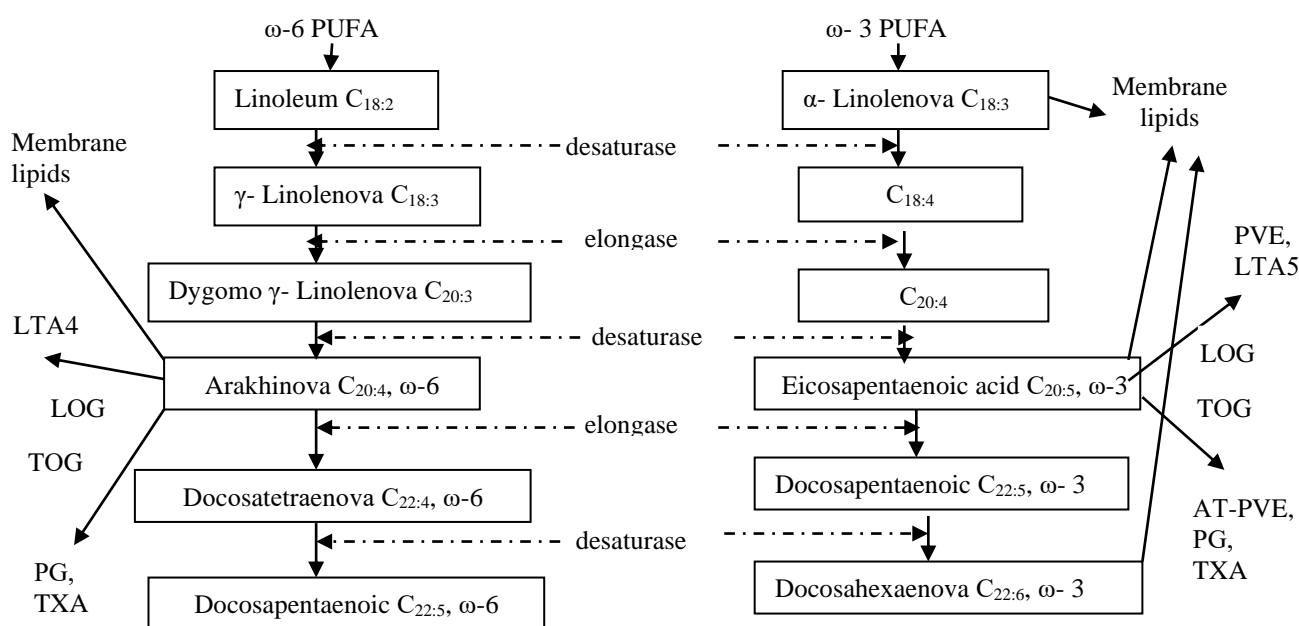


Fig. 3. Scheme of conversion of ω -6 and ω -3 PUFAs into eicosanoids and docosanoids



Table 2 - Fatty acid composition of feed fats and oils

Name of fatty acids		Mass fraction of fatty acids, %							
		Palm oil	Sunflower oil	Soybean oil	High-oleic sunflower oil	Fish oil	Linseed oil	Coconut oil	Animal fat
saturated	Laurynova (12:0)	0,15	-	-	-		-	45,08	0,2
	Arakhinova (20:0)	1,0	0,2	0,35	0,19		0,07		0,5
	Miristynova (14:0)	0,9	0,23	0,18	0,04	6,46	0,15	22,85	2,5
	Palmytynova (16:0)	41,00	7,85	12,07	5,19	12,61	4,41	12,36	31,0
unsaturated	Palmitooleinova (16:1)	0,5	0,19	0,15	0,04	9,5	0,11	-	6,0
	Stearynova (18:1)	5,0	3,74	5,96	3,25	5,28	3,02	13,95	14,0
	Oleinova (18:1)	37,0	29,7	24,75	82,36	8,52	26,54	0,17	35,0
	Linoleum (18:2)	7,5	55,69	47,82	5,83	2,7	14,01	0,05	6,0
	Linolenova (18:3)	0,5	0,07	6,57	0,09	0,03	50,48	-	0,5
	Eicosapentaenoic acid (20:5)				-	18,97	-	-	-
	Docosapentaenoic acid (20:5)				-	1,57	-	-	-
	Docosahexaenova (22:6)				-	13,75	-		-
Correlation ω -6/ ω -3		15,0	795,6	7,3	64,7	0,1	0,3	0,05	12,0

At the next stage of research, the FAC of the studied fats and oils was determined and the ratio of ω -6 and ω -3 PUFA was calculated in them (Table 2).

As can be seen from Table 1, oils and fats differ significantly in terms of their dietary fiber FAC. Palmitic acid accounts for 41% of the fatty acids in palm oil. The high content of palmitic acid in animal fat is 31%.

Due to a number of problems, animal fat is not used in practice today in the production of compound feed.

The experience of using palm oil has revealed the following problems:

- palmitic acid in palm oil is represented by isomers Sn-1, Sn-2, which do not form mixed micelles with bile salts and are not absorbed, but on the contrary, form non-absorbable complexes with calcium, which are excreted from the body, which leads to a violation of mineral metabolism, as well as an increase in the viscosity of feces, bloating, colic, etc. Reduction of calcium absorption by 15-20%;

- the use of palm oil is a factor in the excessive accumulation of fat in the body (due to low oxidation capacity), which leads to a violation of animal health, excessive fatty meat, significant accumulation of cholesterol, livestock products do not meet the needs of the consumer;

- palm oil is a source of 3-monochloropropane-1,2-diol (3 MHPD), which has a toxic, carcinogenic effect, promotes cancer, diseases of the cardiovascular system, obesity, dysbiosis, etc.

- saturated fatty acids have a low micelle-forming potential, which reduces their availability, they are oxidized during physical exertion, which cannot always be ensured in modern conditions of maintenance and with

the physiological features of high-performance animal breeds and poultry crosses [13].

The energetic function of fodder fats largely depends on the content of oleic acid (C18:1), which is easily oxidized in the mitochondria with the formation of ATP.

According to their ability to penetrate the cell and be oxidized, fatty acids are placed as follows: oleic, palmitic, linoleic, stearic, erucic [4, 5].

In the studied fats and oils, the content of oleic acid ranged from 0.17% (coconut oil) to 82.36% (high-oleic sunflower oil). In sunflower oil of the traditional (linoleic type), this indicator is 29.77% and 24.75%, respectively.

The feasibility of using oleic acid is confirmed by the studies of Cachaldora et. el, they established that it is able to stimulate the growth and reproduction of probiotic microflora, in particular lactobacilli. contributes to a significant improvement of organoleptic properties of chicken eggs, in particular taste, aroma, in comparison with linoleic type oil. It has been established that the use of high-oleic sunflower oil contributes to the accumulation of docosahexaenoic acid in the yolk. Research by Ortiz et al. found that the use of oil with a high content of oleic acid in diets contributes to the preferential accumulation of oleic acid 521 and 572 g/kg of total fatty acids of the pectoral muscles and thighs, respectively, as a result of which the quality and safety of poultry meat is significantly improved, in particular resistance to oxidative processes, accumulation of toxic products of lipid peroxidation [2, 3].

Coconut oil is characterized by a high content of stearic acid (13.95%), lauric acid (45.08%), myristic acid (22.85%), which are short-chain and can be absorbed



without the stages of splitting and emulsification, which is important for young animals in which insufficiently formed digestive system.

Traditional sunflower oil (linoleic type), soybean oil contain the majority of linoleic acid in their composition (47.8-55.6%), which belongs to the ω -6 series and has a number of negative physiological effects (Table 1), which can be leveled by ω -3 fatty acids, but they are practically absent in the composition of these oils. The use of such oils as the only source of fat, which happens in practice today, is the cause of various metabolic disorders, diseases, and low feeding efficiency.

The negative effects of an excess of unsaturated fatty acids are established:

- violation of mineral metabolism, increased release of calcium and magnesium salts from the body;
- violation of the ratio of ω -6 and ω -3 PUFAs in the body;
- inflammation, increased permeability of the intestinal barrier, which leads to metabolic syndrome;
- appearance of offspring with intestinal inflammation and fibrosis already at birth
- formation of a significant amount of free radicals, which initiate various disorders, oxidation products are carcinogens, poison the body, reduce the immunity of farm animals and poultry;
- deterioration of the quality of livestock and poultry products (excessive softening of lard, low stability of meat during storage, negative impact on human health of oxidation products, fragility of egg shells, etc.);
- high surface activity of fatty acids results in envelopment of bacterial cells of the rumen and complicates the digestion of cattle [4, 5, 14].

The source of ω -3 fatty acids can be linseed oil, fish oil, which also contains docosapentaenoic and docosahexaenoic acid.

At the next stage of research, the ratio of ω -6/ ω -3 PUFAs in the studied fats and oils was determined and compared with the composition of the biological membranes of the animal body (table 3).

As can be seen from Table 2, a fairly significant fluctuation of the ω -6/ ω -3 PUFA ratio in the studied oils

Table 3 - Ratio of ω -6/ ω -3 PUFAs in membrane phospholipids of various organs of mice [12]

Organ	PUFA content, %		ω -6/ ω -3
	ω -6	ω -3	
Erythrocytes	14,2	7,7	1,86
Liver	11,0	5,6	1,96
Brain	17,6	12,9	1,36
Heart	12,4	8,9	1,39

and fats was found, from 0.05 in coconut oil to 795.6 in sunflower oil of the linoleic type.

The vast majority of ω -3 PUFAs and the ratio of ω -6/ ω -3 PUFAs up to 0.3 are found in fish oil and linseed oil.

From 7.3 to 64.7 ratio of ω -6/ ω -3 PUFA in soybean oil, palm oil, high-oleic sunflower oil.

And an order of magnitude higher - 795.6 ratio of ω -6/ ω -3 PUFA in sunflower oil of the linoleic type (traditional).

As can be seen from Table 3, the ratio of membrane phospholipids in various organs of the mice varies from 1.36 to 1.96.

The expediency of adjusting the optimal ratio of these PUFAs close to physiological needs (4...1 to 1) is obvious.

The situation that has developed in practice absolutely contradicts this approach. To date, sunflower oil of the linoleic type is mainly used in Ukraine to balance rations in terms of energy. Its introduction to provide feed with energy leads to a significant increase in the content of linoleic acid, which is also related to the structure of the raw material base and the significant content of ω -6 PUFA in other feed products.

At the next stage of research, a number of compound feed recipes were calculated for different species and groups of poultry (table 4).

It was established that even if flour of animal origin (fish and meat and bone) is used, there is a 3-fold increase in the content of linoleic acid in compound feed

Table 4 - Composition and nutritional value of calculated compound feed recipes for different species and groups of poultry

№	Ingredient	Content in the recipe, %				
		CF-5-1-2, for broiler chickens 1-3	CF-5-1-7 for broiler chickens 1-3	CF-6-114 for broiler chickens KOB-500 finish	CF-2-108 for hens of egg crosses 1-7 weeks	CF- 32-112 for geese 4-8 weeks
1	Corn	54,6	47,5	52,9	5,5	22
2	Wheat	-	-	-	40,4	
3	Barley without film					40
4	Triticale	-	-	5,0	5	
5	Shrot soy (48%)	12,4	-	-		
6	Feed wheat flour			0,6	10	3,2
7	Whole grain soy (34%)	-	18,1	20,0	20	
8	Sunflower meal, CP 38%, CF 15%	14,0	1,4			10



Continuation of Table 4

9	Soy meal, CP 48%	-	24,0	3,8	9,5	11
10	Sunflower cake, CP 34%, CF 18%	-	-	7,0	0,4	
11	Fish flour, CP 67%	9,95	-			
12	Meat-bone flour, CP 48%	4,16	-			
13	Feed yeast, CP 44%	-	1,00	3,00	2,95	5,0
14	Sunflower oil	3,0	2,9	2,9	1,6	3,3
15	Lysine monochlorhydrate 98%	0,14	0,14		0,1	0,1
16	DL- methionine 98,5%	0,15	0,29	0,33	0,16	0,16
17	Lysine sulfate			0,41		
18	L-threonine 98%	-	0,04	0,07		
19	L- tryptophan 98%	-	-	0,50		
20	Feed chalk	0,6	1,9			1,83
21	Feed free phosphate	-	-	1,4	1,77	2,0
22	Limestone flour	-	-	0,9	1,2	
23	Mono calcium phosphate	-	1,3		0,2	
24	Kitchen salt	-	0,43	0,19	0,22	0,3
25	Sodium bicarbonate					0,1
26	Sodium sulfate anhydrous					0,01
27	Premix	1,0	1,0	1,0	1,0	1,0

Nutritional value

№	Indicator	Norms of needs		Content in the recipe		Norms of needs		Content in the recipe		Norms of needs		Content in the recipe	
		Norms of needs	Content in	Norms of needs	Content in the recipe	Norms of needs	Content in the recipe	Norms of needs	Content in the recipe	Norms of needs	Content in the recipe		
1	Exchangeable energy, Kcal/100g	310	3	310	310	300	320	290	296	280	283		
2	Crude protein, %	23	2	23	23	19,0	19,0	20	20,53	18	18,6		
3	Linoleic acid, %	1,1	3	1,1	4,3	1,1	5,31	1,1	3,58	1,4	3,06		
4	Crude fiber, %	< 4	4	< 4	4,0	< 4	3,88	< 4	3,6	< 6	3,99		
5	Lysine,%	1,36	1	1,36	1,3	1,1	1,1	1,1	1,1	0,9	0,9		
6	Methionine, %	0,53	0	0,53	0,6	0,49	0,62	0,5	0,45	0,45	0,45		
7	Methionine+Cystin, %	0,98	0	0,98	0,9	0,9	0,92	0,75	0,79	0,7	0,75		
8	Threonine, %	0,91	0	0,91	0,9	0,75	0,75	0,7	0,74	0,55	0,68		
9	Tryptophan, %	0,25	0	0,25	0,2	0,19	0,71	0,2	0,26	0,2	0,23		
10	Arginine, %	1,25	1	1,25	1,5	1,17	1,17	1,2	1,29	0,9	1,14		
11	Isoleucin, %	0,88	0	0,88	0,9	-	-	-	-	-	-		
12	Leucine, %	1,61	1	1,61	1,9	-	-	-	-	-	-		
13	Valine, %	0,98	1	0,98	1,0	-	-	-	-	-	-		
14	Histidine, %	0,48	0	0,48	0,6	-	-	-	-	-	-		
15	Phenylalannine, %	0,8	1	0,8	1,1	-	-	-	-	-	-		
16	Phenylalannine+Tyrosine, %	1,49	1	1,49	1,9	-	-	-	-	-	-		
17	Ca, %	1	1	1	1,0	0,84	0,85	1,1	1,13	1,2	1,34		
18	P, %	0,7	0	0,7	0,7	0,4	0,40	0,8	0,80	0,8	0,81		
19	P assimilated, %	0,4	0	0,4	0,4	0,65	0,65	0,5	0,52	0,45	0,52		
20	Na, %	0,2	0	0,2	0,2	0,16	0,16	0,2	0,20	0,3	0,30		



(up to 3.08% against the norm of 1.1%). But taking into account the presence of fish meal in the compound feed and, accordingly, ω -3 PUFA in the fat, it is possible to predict the leveling of negative effects due to the regulatory effect of these acids, as noted earlier (Table 1, Fig.2).

It was established that despite the choice of different types of grain and protein raw materials for all recipes, it is impossible to simultaneously ensure the energy nutrition of the compound feed and meet the physiological needs for the content of linoleic acid. Thus, the additional introduction of sunflower oil of the linoleic type leads to an increase in the indicator for various recipes and types and groups from 3.0 to 5 times.

Taking into account the absence of sources of ω -3 PUFA in the composition of fodder, it is possible to predict a violation of lipid and mineral metabolism, the

appearance of pathological conditions, a decrease in the productivity of animals and poultry, and obtaining low-quality livestock and poultry products.

Conclusions

1. The substantiation of FAC of compound feed products will allow to correct the ways of metabolism and biosynthesis of lipids, to carry out the predicted physiological and functional effect on the body of farm animals and poultry in order to obtain livestock and poultry products of maximum quantity and high quality.

2. Further research is needed to substantiate the choice of fats and fat-containing feed additives, to improve the calculation of recipes for compound feed products, taking into account optimization not only by the amount of fat, but also by the fatty acid profile.

REFERENCES

1. Bratyshko, N. I., Ionov I. A., Ibatullin I. I., Prytulenko O. V., Klymenko T. I., Kotyk A. M., Katerynch O. O., Zhukorskyi O. M., Havilei O. V., Poliakova L. L., Hrytsenko R. B. (2013) Efektyvna hodivlia silskohospodarskoi ptysi /za red. I. A. Ionova ; Nats. akad. ahrar. nauk Ukrainy, In-t tvarynnytstva. Kyiv: Ahrar. nauka, 207 [in Ukrainian].
2. Cachaldora, P., García-Rebollar, P., Álvarez, C., Méndez, J., & De Blas, J. C. (2005). Effect of conjugated linoleic acid, high-oleic sunflower oil and fish oil dietary supplementation on laying hen egg quality. *Spanish Journal of Agricultural Research*, 3(1), 74-82. [in English].
3. Ortiz Vera, L. T., Alzueta Lusarreta, C., Rebolé Garrigós, A., Rodríguez Membibre, M. L., Arija Martín, I., & Brenes Paya, A. (2006). Effect of dietary high-oleic acid and conventional sunflower seeds and their refined oils on fatty acid composition of adipose tissue and meat in broiler chickens. [in English].
4. Zubar, N. M. (2010) *Osnovy fiziologii ta hihieny kharchuvannia*: Pidruchnyk. K.: Tsentr uchbovoi literatury, 2010. 336. [in Ukrainian].
5. Tiutiunnykov B. N., Bukhshtab, Z.I.; Hladkyi, F.F. Demydov, I.M.; Melnyk, A.P.; Hladkyi, F.F. (2002) *Khimiia zhyriv : pidruchnyk*. Kharkiv: NTU «KhPI», 452. [in Ukrainian].
6. Stavetska, R.V. Vplyv selektsiino-henetychnykh fa ktoriv na dobrobut produktyvnykh tvaryn. URL: https://ciwf.in.ua/wp-content/uploads/2016/06/%D0%94%D0%BE%D0%B1%D1%80%D0%BE%D0%B1%D1%83%D1%82_%D0%A1%D1%82%D0%B0%D0%B2%D0%B5%D1%86%D1%8C%D0%BA%D0%B0.pdf [in Ukrainian].
7. Knowles, T. G., Kestin, S. C., Haslam, S. M., Brown, S. N., Green, L. E., Butterworth, A., ... & Nicol, C. J. (2008). Leg disorders in broiler chickens: prevalence, risk factors and prevention. *PloS one*, 3(2), e1545. [in English].
8. Levitsky, A.P., Egorov, B.V., Lapinskaya, A.P., & Selivanskaya, I.A. (2020). Inadequate fat diet. *Journal of Education, Health and Sport*, 10(7), 248-255. [in English].
9. Levyskyi, A. P., Volianskyi, Yu. L., Skydan, K. V. (2008) *Prebyotyky y problema dysbakterioza*. Kharkov: ЭДЭНА, 100. [in Russian].
10. Daniel Borda-Molina, Jana Seifert, Amélia Camarinha-Silva (2018) Current perspectives of the chicken gastrointestinal tract and its microbiome // *Computational and Structural Biotechnology Journal*. 16. 131-139. [in English].
11. Serhan, C.N. (2007). Resolution phase of inflammation: novel endogenous anti-inflammatory and proresolving lipid mediators and pathways. *Annu. Rev. Immunol.*, 25, 101-137. [in English].
12. Valenzuela, R., Echeverria, F., Ortiz, M., Rincón-Cervera, M. Á., Espinosa, A., Hernandez-Rodas, M. C., ... & Videla, L.A. (2017). Hydroxytyrosol prevents reduction in liver activity of Δ -5 and Δ -6 desaturases, oxidative stress, and depletion in long chain polyunsaturated fatty acid content in different tissues of high-fat diet fed mice. *Lipids in health and disease*, 16, 1-16. [in English].
13. Ferrini, G., Baucells, M.D., Esteve-García, E., & Barroeta, A.C. (2008). Dietary polyunsaturated fat reduces skin fat as well as abdominal fat in broiler chickens. *Poultry Science*, 87(3), 528-535.
14. Attia, Y.A., Al-Harathi, M.A., & Abo El-Maaty, H.M. (2020). The effects of different oil sources on performance, digestive enzymes, carcass traits, biochemical, immunological, antioxidant, and morphometric responses of broiler chicks. *Frontiers in Veterinary Science*, 7, 181.



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ОПТИМІЗАЦІЯ ЖИРНОКИСЛОТНОГО СКЛАДУ КОМБІКОРМОВОЇ ПРОДУКЦІЇ. ПРОБЛЕМИ І ПЕРСПЕКТИВИ

Анотація

Проаналізовано сучасні тенденції та зміни щодо виробництва харчових та кормових продуктів, стан природно-ресурсного забезпечення людства, фізіологічні особливості сучасних високопродуктивних порід тварин і кросів птиці, особливості їх утримання, структуру сировинної бази комбікормової промисловості та обґрунтовано необхідність зміни підходів до забезпечення комбікормової продукції жиром. Показано, що обмеженість по введенню рибного та м'ясо-кісткового борошна в рецепти комбікормів потребує заміни цих компонентів не тільки з точки зору повноцінності білка, але і необхідність коректування жиру як по кількості для забезпечення необхідного рівня енергетичної цінності, так і по якості для забезпечення здорової життєдіяльності організму. Показано, що організм тварин, птиці це симбіоз двох організмів макроорганізму і мікробіоти, із вагомою часткою внеску у спільне співіснування мікробіоти, тому обґрунтування вибору компонентів комбікормової продукції, зокрема для забезпечення жиром та енергією, потрібно проводити із урахуванням подальшого впливу на мікробом. Показано актуальність оптимізації жирнокислотного складу (ЖКС) комбікормової продукції згідно з фізіологічними та метаболічними потребами сучасних порід та кросів сільськогосподарських тварин та птиці. Проаналізовано сучасні уявлення про шляхи метаболізму жирів, фізіологічну роль окремих жирних кислот, біологічну цінність та розроблено теоретичні засади оптимізації жирно кислотного складу. Встановлено, що насичені жирні кислоти відрізняються вищою стійкістю до окиснення, здатні підвищувати імунітет, знизити запалення, проте мають низький ступінь засвоєння, і потребують обов'язкового корегування біодоступності для уникнення порушення ліпідного обміну. Мононенасичені жирні кислоти мають більш краєву стійкість до окисних процесів, вищу доступність. Поліненасичені жирні кислоти (ПНЖК) мають низьку та дуже низьку стійкість до окисних процесів, що зумовлює необхідність вирішення питання їх стабілізації як *in vivo* так *in vitro*, оскільки накопичення токсичних продуктів перекисного окиснення ліпідів ініціює появу різних патологій та захворювань. Визначено ЖКС олії пресової та нерафінованої соняшникової і соєвої, високоолеїнової соняшникової, пальмової, кокосової, лляної; риб'ячого жиру ветеринарного та розраховано в них співвідношення ω -6 і ω -3 ПНЖК, обґрунтовано переваги та недоліки їх використання в комбікормах. Показано, що введення олії соняшникової лінолевого типу для забезпечення комбікорму енергією призводить до значного перевищення вмісту лінолевої кислоти, що пов'язано із структурою сировинної бази та значним вмістом ω -6 ПНЖК у інших кормових засобах. Розраховано рецепти комбікормів для різних видів та груп сільськогосподарської птиці, встановлено, що при використанні рибного та м'ясо-кісткового борошна спостерігається перевищення вмісту лінолевої кислоти в комбікормі у 3 рази (до 3,08 % при нормі 1,1 %. Додаткове введення олії соняшникової лінолевого типу призводить до зростання показника для різних рецептів та видів і груп від 3,0 до 5 разів, що призводить до порушення ліпідного, мінерального обміну, появу патологічних станів, зниження продуктивності тварин та птиці, отримання низької якості продукції тваринництва та птахівництва. Обґрунтування ЖКС комбікормової продукції дозволить корегувати шляхи метаболізму та біосинтезу ліпідів, здійснювати прогнозовану фізіологічно-функціональну дію на організм сільськогосподарських тварин та птиці з метою отримання продукції тваринництва і птахівництва максимальної кількості та високої якості. Необхідні подальші дослідження щодо обґрунтування вибору жирів і жиромісних кормових добавок, удосконалення розрахунку рецептів комбікормової продукції із врахуванням оптимізації як за жиром, так і жирнокислотним профілем.

Ключові слова: жир, жирнокислотний склад (ЖКС), комбікорм, пальмова олія, соняшникова олія, високоолеїнова олія, риб'ячий жир, поліненасичені жирні кислоти (ПНЖК).

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